Role of cognitive resources on everyday functioning among oldest-old physically frail

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Abstract:

Background: Everyday functioning becomes a challenge with aging, particularly among frail oldest-old adults. Several factors have been identified as influencing everyday activities realization, including physical and cognitive functioning. However, the influence of cognitive resources as a compensatory factor in the context of physical frailty deserves further consideration.

Aims: This study aims to investigate in older adults physically frail the possible compensatory role of cognitive resources to perform everyday tasks.

Methods: Two groups of community-dwelling old participants (n=26 per group) matched for their age and cognitive resources, have been drawn according to their level of physical functioning. Two measures of everyday functioning have been assessed: one self-reported by the participant (the IADL scale) and one performance-based measure (the TIADL tasks).

Results: Participants performed equally the TIADL tasks irrespective of their physical condition. Contrariwise, participants with low physical functioning reported more everyday difficulties than their counterparts with a high level of physical functioning. Additionally, regressions analyses revealed differential influence of cognitive resources on performance and reported measures of everyday functioning.

Discussion: Our data suggests that cognitive resources are more strongly involved in the performance-based IADL measure in situation of physical frailty. Additionally, for participants with low physical functioning, lower cognitive resources are associated with more perceived difficulties in everyday life.

Conclusion: These results highlight the compensatory role of cognitive resources in physically frail older adults, and suggest that an overestimation of everyday difficulties compared to performance on IADL tasks is an early indicator of physical decline and cognitive compensation.

Keywords: aging; physical functioning, cognitive resources, daily life activities, compensation

BACKGROUND

Aging is a multifactorial process, which is influenced by a large number of physical, psychological and social variables. While many persons experience healthy aging without significant impairments, sensory, motor and cognitive decline can occur with age. In any case, the capacity to perform activities of daily living can be affected. In this study, we focus on the compensatory role of cognitive resources on independent everyday functioning among older adults who have reduced physical functioning.

Independent everyday functioning and its assessment

Independent everyday functioning, commonly called functional status, refers to the individual's abilities to autonomously perform activities of daily life (ADL)[1, 2]. ADLs include basic (BADLs) and instrumental (IADLs) activities of daily living[3, 4]. The former refer to basic, physical, self-care tasks, such as ambulating, dressing, grooming, toileting, eating, etc. The latter activities are more complex self-care tasks, such as meal preparation, medication and financial management, etc. Hence, IADLs entail more cognitively complex tasks than BADLs[3]. The IADL-related abilities are often assessed through self-reports or proxy ratings of an individual's ability to perform activities. IADL questionnaires commonly used in the older adult population include the Multilevel Assessment Instrument[5], the SF-36[6] and the OARS Multidimensional Functional Assessment Questionnaire[7]. As these questionnaires can generate biases and inaccuracies in the informant's perceptions, they are increasingly being complemented with objective performance measures of physical and cognitive tasks important for everyday functioning, such as the Timed Instrumental Activities of Daily Living test (TIADL[8]; for a review of such ADL measures, see[9]). To be noted, while with cognitively impaired older adults, a discrepancy has been observed between self-reported and objective measure of everyday functioning[10], in cognitively healthy old people, self-reported ADL measures still remain strongly related to objective measures of everyday functioning[11, 12].

Main underpinnings of age-related changes in independent everyday functioning

Autonomy in daily living has been shown to be influenced by a number of factors. First, ADL performance is related to socio-demographic variables, such as age, gender, education, and marital status[1, 13, 14]. For instance, over a longitudinal study with more than 3,000 participants, authors found that women with an advanced age and lower education were more likely to develop poorer functional status in the next 4 years [13].

Cognitive functioning is also well documented as major underpinnings of functional status[11, 15, 16]. Indeed, as noted earlier, BADLs and even more so IADLs require the involvement of cognitive resources to remember, plan, focus, read or count during everyday activities realization. Notably, better performance with IADL has been shown to be associated with better prospective memory (*i.e.*, remember and execute delayed intentions)[13], better inductive reasoning (*i.e.*, find a common rule from several examples)[16] and better vocabulary[11]. To note, cognitive functioning in older adults is usually assessed with specialized tools providing a global measure of cognition (such as the DRS-2 [19]) or with specific measures of cognitive functions sensitive to aging such as executive functioning (e.g., the FAB [18]).

Similarly, there is ample evidence for a positive relationship between poorer physical aptitude (often called physical frailty[20, 21]) and higher-level ADL loss[22–25]. Indeed, muscle strength, balance, vision, or hearing, are commonly decreasing with age, which may lead to serious ADL limitations. For instance, an impaired balance renders the gait uncertain (*i.e.*, with possible negative outcomes like falls or even sickness), which, in turn, may cause a person to avoid or reduce their mobility[26].

Taken together, these findings stress that the ADL decline with aging is multi-determined and that the understanding of managing aspects of physical and cognitive functioning into ADLs is likely to be a fruitful way for giving insight into everyday functioning in later life.

Relationships between Cognitive and Physical functioning to perform ADLs in aging

Beside their independent influence over everyday functioning, there is growing evidence suggesting that cognitive and physical functioning tend to be closely intertwined in late adulthood. Notably, in studies using dual tasks[27–29] or even naturalistic tasks like planning a route while walking[30] it is observed that older adults tend to "prioritize" sensorimotor processing over cognitive processing. In other words, when dual "cognitive-sensorimotor" abilities are necessary, for instance when walking while reading a map, older adults tend to reduce their performance on the cognitive task (*i.e.*, planning) to maintain their sensorimotor performance (*i.e.*, walking)[30]. Besides, some authors even argue that walking in old age is *per se* a dual task[29]. This age-related condition directly impacts ADLs which require simultaneous coordination of physical and cognitive functions.

The age-related changes in the coordination of physical and cognitive functions can be related to the issue of compensation: a strategy responding to functional decline in old age that is described by the model of selective optimization with compensation (SOC)[31]. Applied to the situation of gait and balance loss in later life, compensation means that due to a significantly reduced physical aptitude in daily life, older adults are forced to rely more intensively on cognitive resources to conduct ADLs[32]. Notably, the study of Heyl and Wahl[2] tested the involvement of cognitive resources to compensate sensory impairment in the context of ADL tasks. Indeed, these authors found that cognitive resources and behavior-related everyday functioning are more closely related in older adults having sensory impairments as compared to sensory unimpaired counterparts. Authors discussed their results in the light of the SOC model, and suggest the promotion of cognitive training to support everyday life of elders living with sensory impairment.

In this line of research, the present study attempts to provide further evidence for the involvement of cognitive resources in the maintenance of ADLs in physically frail oldest-old adults. The population selected is a sample of cognitively healthy older adults who are divided into two groups on the basis of their performance on tests assessing their physical functioning (in terms of mobility, corporal balance, body mass and sensory functions). The expected results are that older adults having physical disturbances rely more on their cognitive resources to successfully perform ADL tasks for coping with their physical decline. However, as they are cognitively spared, they should accurately self-perceive their limitations for carrying out ADL tasks.

METHODS

Recruitment and final participants

To test our research assumptions, it was essential to include older participants with physical limitations. For this reason, we collaborated with three public home services for elders randomly selected among all the Gironde municipalities with a location criterion as follows: one urban, one semi-urban and one rural location. In France, the level of public financial support for home service is determined by the functional status. As a result, each file of a home-service beneficiary is documented by the results of a geriatric assessment performed by medical consultants, according to the AGGIR scale (gerontological ISO norms for autonomy practiced in France to establish a person's functional status). Within our sample, the individuals presenting a dependency syndrome (GIR-score inferior to 4) were excluded from the study. Among the remaining individuals, we conducted around a hundred of phone calls and 86 older adults accepted to participate to the study. They underwent a battery of tests. All the interviews were done at the person's home across two sessions. Thirty-four elders were excluded from the study because of their MMSE score (< 27) to avoid pathological cognitive impairment, such as dementia cases. Then, we created our two groups of subjects regarding their physical functioning scores (see below for the calculation of this score). Eventually, the study sample consisted of 52 community-dwelling old adults aged between 73 to 94 years (mean age 82.2 ± 4.7); 9 males and 43 females; they were still autonomous and without cognitive impairment.

Assessment of Physical functioning

Tasks were selected from widely used clinical and research scales for assessing physical functioning and subsequent frailty [33, 34] as follows:

Five Chair Stands (lower body strength): The participant is asked to stand up from a chair five times without using their arms. The time is recorded and the test is scored from 4 - the participant takes less than 11.1 sec to complete the task to 0 – the participant is unable to perform task.

Static Balance Testing consists of three sorts of standing: side-by-side stand, semi-tandem stand and tandem stand; each of them scored from 4 – the participant holds the three standing positions for more than 10 sec; to 0 – the participant did not attempt any standing position.

Timed Get Up and Go Test (agility and dynamic balance). This test consists of rising from a chair, walking three meters, turning around, walking back to the chair, and sitting down. Time in seconds to complete the task is recorded. The task is scored as followed: 1 – the task is completed in more than 30 sec, 2- the task is completed from 20 to 30 sec, and 3 - the task is completed in less than 10 sec (in this case, mobility is considered normal).

Gait Speed Test corresponds to a timed 4-meter walk. It is scored from 4 – time is less than 4.82 sec – to 0 – the participant was unable to do the walk.

The score from these four tests ranged from 0 to 13 with higher values indicating greater mobility function.

Body mass is also an important component of physical frailty[21]. Thus, two indices have been scored based on the Mini-Nutritional Assessment[35]. First, the Body Mass Index (BMI), scored from 0 to 3 with higher values indicating higher BMI values. Second, the brachial and calf perimeters are scored from 0 to 2 with higher values indicating higher lean mass values.

Summed, the two indices provide a score from 0 to 5, with a higher score indicating a better body mass.

Finally, *sensory abilities*, particularly visual acuity and hearing were assessed with a three-point Likert-type scale, ranging from 0 to 2 (where 0 corresponds to the highest sensory loss). So, sensory scale provided score ranged from 0 to 4 with higher scores indicating better sensory functions.

So, the score from all test ranged from 0 to 24 with higher values indicating greater physical functioning (see Table 1). From this score, participants were then divided into two subgroups based on their physical performance (see below): participants above the physical functioning score median were considered as 'high physical functioning' (n=26, 5 males and 21 females), whereas other participants were considered as 'low physical functioning' (n=26, 4 males and 22 females). These two groups were equivalent in terms of socio-demographic characteristics, cognitive functioning (including Mini-Mental State Evaluation, MMSE[36]; and Cognitive resource score described below), and cognitive complaint (assessed by Cognitive Difficulties Scale, CDS[37]) (see Table 1).

Table 1: Characteristics of the two groups of older participants according to the level of physical functioning (High vs. Low Physical Functioning)

	Physical Functioning			
	Low Mean (SD)	**High** Mean (SD)	*Group comparison*	*Effect size (η^2) Obs. power (β)*
Age	83.12 (.88)	81.12 (.95)	$t(50) = 1.54; p = .13$	$\eta^2 = 0.045$
Gender (% female)	80.77	84.61	$t(50) = .36; p = .72$	$\eta^2 = 0.002$
Education years	9.81 (.45)	8.96 (.49)	$t(50) =1.27; p = .21$	$\eta^2 = 0.031$
Family Status (% married)	23.08	19.23	$t(50) = .333; p = .74$	$\eta^2 = 0.002$
MMSE (max. = 30)	28.26 (0.24)	28.35 (.25)	$t(50) = -.26; p = .78$	$\eta^2 = 0.001$
Physical functioning score (max. = 24)	13.40 (.77)	20.62 (.32)	$\boldsymbol{t(50) = -8.67; p < .0001}$	$\boldsymbol{\eta^2 = 0.600}$ $\boldsymbol{\beta = 1.000}$
Cognitive Resources score (max. = 174)	146.24 (3.31)	150.30 (1.68)	$t(50) = -1.809; p = .28$	$\eta^2 = 0.061$
CDS (max. =144)	42.95 (4.26)	34.33 (3.68)	$t(50) = 1.53; p = .13$	$\eta^2 = 0.045$

Note. SD=standard deviation; MMSE=Mini-Mental Status Exam; CDS=Cognitive Difficulties Scale.

Assessment of cognitive resources

General cognitive functioning: The Dementia Rating Scale-2 (DRS-2)[19] has been used. It assesses five cognitive domains, including attention (*e.g.*, forward and backward digit span, ability to follow commands), initiation – perseveration (semantic fluency, motor fluency and perseveration), abstraction (conceptualization from verbal and non-verbal stimuli), visual-constructional abilities (copy of geometric figures and signature writing) and verbal as well as non-verbal memory (recall and recognition). This scale gives a score between 0 and 144 (where 144 is the best score).

Executive functioning: The Frontal Assessment Battery (FAB)[18] has been administrated. It probes several domains including conceptualization, mental flexibility, motor programming, resistance to interference, self-regulation, inhibitory control, and environmental autonomy. FAB gives a score ranging from 0 to 18 (where 18 is the maximum score).

The cognitive resource measure refers to the sum of scores obtained on each scale (with a maximum score of 162). As indicated in Table 1, the two groups of old participants did not differ for the cognitive resource measures.

Assessment of everyday functioning

Performance based assessment. We administrated the TIADL Tasks[8], composed of five timed tasks that simulate everyday instrumental activities of daily living: communication (finding a telephone number in the telephone directory), finance (finding and counting out correct change of money), cooking (finding and reading the ingredients on three food cans), shopping (finding two specific items in an array of food items) and medicine (finding and reading the directions on medicine containers). Each task is scored as 1 – completed without errors and within the time limit, 2 – completed with minor errors, or 3 – not completed within the time limit, or completed with major errors. Thus, the TIADL gives a score range from 5 to 15, higher scores indicating more difficulties to perform the tasks.

Self-report assessment. We assess a 24-items scale based on ADL and IADL items [5], where the answer is based on a 5-point Likert-type format varying from 0 – not at all difficult, to 4 – very difficult. Then, we selected the 15 IADL items to identify the self-reported IADL score. Thus, the self-reported IADL gives a score range from 0 to 60, higher scores indicating more complaint about IADL tasks.

Assessment of Self-perceived health. We assess the health-related quality of life using the Short Form-36 (SF-36) questionnaire[6]. This questionnaire consists of 36 items, covering eight dimensions (physical functioning, physical limitations, body pain, general health, vitality, social functioning, limitations due to emotional problems, and mental health) and provides two summary scores, namely physical score and mental score.

Statistical analyses

First, group comparisons (Low Physical Functioning *vs*. High Physical Functioning) have been performed with the *Student's t test* procedure on each measures of everyday functioning (Table 2). For these tests, t-values, p-values (with a significance level <.05) and effect sizes (η^2) were reported. As our final sample ended up relatively small, we added post-hoc power sensitivity analyses (observed power β) to prevent from Type-I errors (*i.e.,* false positive conclusions) when significance was observed.

Second, global correlations including all participants have been carried out between measures of everyday functioning and cognitive functioning scores (Table 3). Third, to assess the influence of the Cognitive Resource factor on IADL measures, two multiple linear regression analyses were carried out in the two groups independently, with the following statistical design: physical functioning score and cognitive resource score as predictors, and TIADL and self-reported IADL scores as criterion variables. In these four regressions, percentage of the variance explained by the model (Adjusted R^2), and unstandardized (B) and standardized (β)

regression coefficients for the variables entered into the model were reported (Table 4). Each effect size was computed with η_2. All data analysis was performed using SPSS 20.0.

RESULTS

Effects of physical functioning level on everyday functioning (Table 2)

In terms of *performance-based assessment*, the Low and High Physical Functioning groups had nearly similar performance on the TIADL test (t(50) = .968 ; p > .300; $\eta^2 = 0.018$). Interestingly, in terms of *self-report assessment*, self-reported difficulties to perform everyday activities (self-report IADL score: $t(50) = 3.27$; $p = .002$) are higher for the Low Physical Functioning group than for the High Physical Functioning group. The strong observed power ($\beta = 89.5\%$) and effect size ($\eta^2 = 0.177$) values suggest that the difference between the two groups is not a false positive.

Concerning the *assessment of self-perceived health*, the two groups of participants did not differ in terms of self-perceived mental health, *i.e.*, SF-36's mental sub-score ($t(50) = -1.32$; $p > .100$; $\eta^2 = 0.034$). By contrast, compared to the High Physical Functioning group, the Low Physical Functioning group performed lower on the SF-36's physical sub-score ($t(50) = -3.76$; $p < .001$), indicating a decreased self-perceived physical health, which does not seem to be due to a false positive result ($\eta^2 = 0.261$; $\beta = 95.8\%$).

Table 2: Performance-based and self-reported measures of Everyday functioning for the two groups of older participants (High vs. Low Physical Functioning group).

	Physical Functioning			
	Low Mean (SD)	**High** Mean (SD)	*Group Comparison*	*Effect size (η^2) Obs. power (β)*
TIADL (max. = 15)	6.15 (0.466)	5.65 (0.221)	*$t(50) = 0.968$; $p = .337$*	*$\eta^2 = 0.018$*
Self-reported IADL (max. = 60)	14.46 (1.72)	7.50 (1.25)	***$t(50) = 3.275$; $p = .002$***	***$\eta^2 = 0.177$ $\beta = 0.895$***
SF-36 physical (max. = 100)	37.28 (4.04)	57.24 (3.45)	***$t(50) = -3.76$; $p < .001$***	***$\eta^2 = 0.261$ $\beta = 0.958$***
SF-36 mental (max. = 100)	55.07 (4.56)	63.41 (4.36)	*$t(50) = -1.32$; $p>.100$*	*$\eta^2 = 0.034$*

Note. SD=standard deviation; IADL=Instrumental Activities of Daily Living; SF-36=Short Form-36.

Global relationships between the everyday functioning measures and the cognitive resources measures (Table 3)

As illustrated in Table 3, the performance-based and self-reported measures of IADL are significantly related with a positive coefficient ($r = .391$; $p = .004$), which means that more difficulties in the TIADL tasks are associated with more reported difficulties in everyday functioning. Similarly, the physical and mental sub-scores of the SF-36 were strongly related with a positive relationship ($r = .513$; $p < .001$).

Table 3: Inter-correlations between measures of everyday functioning and cognitive and physical measures for all participants group.

	TIADL	Self-report IADL	SF-36 physical	SF-36 mental	Cognitive Resources	Physical Functioning
TIADL	-	**.391****	.042	-.058	**-.748*****	**-.343***
Self-reported IADL		-	**-.405****	-.220	-.483***	**-.533****
SF-36 physical			-	**.513*****	.062	**-.440****
SF-36 mental				-	.253	.074
Cognitive Resources					-	**.329***

Notes. * $p < .05$, *** $p < .001$. Significant correlations are bolded

Regarding the relationships with cognitive resources, both performance-based and self-reported measures appeared strongly correlated with cognitive resources but with negative coefficients (TIADL: $r = -.748$; $p < .001$; self-reported IADL: $r = -.483$; $p < .001$), which means that greater everyday difficulties (observed or reported) are associated with lower cognitive resources. Similarly, physical functioning score emerged negatively correlated with TIADL and self-reported IADL scores (TIADL: $r = -.343$; $p = .013$; self-perceived IADL: $r = -.533$; $p < .001$), suggesting that better physical abilities are associated with lower observed or reported everyday difficulties.

Impact of cognitive resources on the relation between physical level and ADL (Table 4)

To assess the relative influence of physical functioning and cognitive resources to manage everyday functioning (and highlight a possible compensatory effect of cognitive resources when physical functioning is limited), multiple regression analyses have been performed on each measure of IADL (TIADL; self-reported IADL) (Table 4).

Table 4: The unstandardized (B), standardized regression coefficients (β), and percentage of variance explained (Adjusted R^2) for the variables entered into the four models

Variables	B	SE B	β	*p*	Adj R^2 (%)
Regression 1 : High PF group – TIADL as criterion variable					
Physical	.002	.115	.002	.989	3.6
Cognitive	-.080	.022	-.605	**.001**	27.5
Regression 2 : High PF group – self-reported IADL as criterion variable					
Physical	-2.071	.648	-.533	**.004**	26.3
Cognitive	-.174	.124	-.233	.175	5.2
Regression 3 : Low PF group – TIADL as criterion variable					
Physical	-.103	.084	-.169	.232	16.2
Cognitive	-.100	.019	-.711	**< .001**	43.2
Regression 4 : Low PF group – self-reported IADL as criterion variable					
Physical	-.281	.422	-.126	.513	6.0
Cognitive	-.254	.098	-.488	**.017**	18.0

Notes. SE: Standard Error; * $p < .05$, *** $p < .001$. Significant predictors are bolded

The four models appeared significant (*Regression 1*: F (2, 25) = 6.640; $p = .005$; *Regression 2*: F (2, 25) = 6.744; $p = .005$; *Regression 3*: F (2, 25) = 19.294; $p = <.001$; *Regression 4*: F (2,

25) = 4.948; p = .016). In both groups, when the TIADL score is entered as the dependent variable (Regression 1 and 3), cognitive resources score was a significant predictor, with a negative relationship with the criterion variable, meaning that more cognitive resources are associated with better performance at the TIADL (*i.e.*, lower scores). In the Low PF group, the adjusted R^2 of the cognitive score coefficient is higher compared to the High PF group, suggesting a stronger importance in variance explanation. In both models, physical functioning score was not a significant predictor. When the self-reported score is entered as the dependent variable, physical score emerged as a significant predictor in the High PF group (Regression 2) with a negative relationship, indicating that lower physical performance is associated with increased complaint about everyday functioning (*i.e.*, higher scores), and cognitive score remained non-significant. In the Low PF group however (Regression 4), physical score appeared non-significant but cognitive score emerged as a significant predictor, with lower cognitive resources associated with an increased complaint about everyday life.

DISCUSSION

Our study is the first to attempt to demonstrate the compensatory role of cognitive resources among physically frail older adults in everyday functioning. For this purpose, we have recruited cognitively healthy elders, who differed only depending on their physical functioning level (Low Physical Functioning *vs.* High Physical Functioning). Performance-based and self-reported measures of everyday functioning have been collected.

A major result is that cognitively healthy elders exhibited similar performance-based everyday functioning irrespective of their level of physical functioning. In other words, old participants with low physical functioning successfully handled their physical limitations to adequately achieve the IADL tasks. Nevertheless, these participants reported more problems regarding IADL realization and physical health than their counterparts with high physical functioning. This indicated that even if elders with low physical functioning remain able to properly perform IADL tasks, they accurately perceive their physical limitations for carrying out such tasks. These results are fully consistent with our expectations and the literature. Indeed, this result reinforces the critical role of physical functioning[22, 24, 26] and cognitive health[15, 16, 22] in self-reported everyday functioning and physical health. Additionally, our results emphasize the possible incongruence between performance and self-reported measure of IADL in physically frail elders. Indeed, normal cognitive aging studies mostly give evidence for congruence between performance-based and self-reported scores of everyday difficulties[11, 12], which is perfectly illustrated in our old participants with high physical functioning. However, when an incongruence between performance and reported IADL (and more precisely an overestimation of difficulties compared to the actual performance) is observed among cognitively healthy elders, while some authors proposed the influence of age[38, 39], cognition[10, 39] or culture[40], this can be an early indicator of physical decline and cognitive compensation process involved. Hence, ADL performance during performance-based assessments probably relies more heavily on cognitive resources than on physical functioning, which is supported by the strong correlation observed between cognitive resources and TIADL scores (irrespective of physical functioning conditions). Such pattern also underlines the limit of performance-based assessments, which exclude individual's chosen routines, strategies and environmental cues that typically facilitate ADL in everyday life[4], and suggest the administration of both performance-based and self-reported measures of everyday difficulties. To sum up, it is clear that the incongruence reported for cognitive healthy elders with low physical functioning deserves to be further studied; notably with regard to the potential role of cognitive functioning as a moderator of physical loss on the performance-based measures of IADL.

Along the line with research by Heyl and Wahl[2] on sensory deficit, we specially addressed the moderating effect of cognitive resources on physical loss during IADL measures. Regression results highlighted that the influence of cognitive resource on performance-based IADL is significantly modified in respect with the level of physical functioning (*i.e.*, adjusted R^2 of the Cognitive resources score with TIADL score as a criterion variable). Importantly, the importance of cognitive resources to predict the variation of performance on IADL tasks is significantly increased by a low physical functioning condition compared to the high physical functioning condition. Consequently, the evidence of a compensatory role of cognitive resource in performance-based IADL for physically frail elders is provided from this angle. Additionally, our compensatory assumption is supported by a second major result. The significant predictors of the self-reported IADL measure differ depending on physical functioning level. The regressions analyses revealed that the variation of IADL difficulties reported by participants with low physical functioning is significantly predicted by their level of cognitive resources. Contrariwise, in participants with high physical functioning, this variation is only predicted by their level of physical functioning. This means that self-reported IADL varies as follows: for the old-old participants with high physical functioning, having physical difficulties (even a few) is the main reason why they would report IADL problems; however, for older adults with low physical functioning, this is the lack of enough cognitive resources that would predict their self-reported IADL problems. In other words, in the situation of physical loss, cognitively healthy older adults who have the least cognitive resources are acutely aware of the cognitive effort they exert to achieve nominal ADL performance. Thus, the additional cognitive effort for maintaining IADL performance in physically frail older adults is probably experienced as more effortful among those having less cognitive resources than those with higher ones. This result goes further the recently published paper showing that cognitive status indirectly affects physical aging in the apparition of disability[23], since it proposed an explanation for this indirect effect, *i.e.*, compensation, as suggested in the SOC Model[2, 31].

Some limitations of this study can be noted. The first is related to the modest size of the sample included in the study (even if we did prevent from false positive conclusions by running power sensitivity analyses). With a larger sample size, statistical power of our results relative to compensatory effect could be reinforced. Second, some studies[15, 16] found differential impact of different cognitive functions on self-reported and performance-based assessment of everyday functioning, while we used a global measure of cognitive resources. Further works could investigate the relations between specific cognitive functions (*e.g.*, mental flexibility or inhibitory control) and measures of everyday functioning for defining more finely which cognitive resource is involved in the cognitive compensation in situations of physical loss. Third, we used scores at the TIADL tasks to measure IADL performance (as suggested by the designer of the test[8]), but finer grain measure of the performance, such as the time used or the type of error (as adapted in[15]) could give further insight of compensation strategies involved in everyday life.

To conclude, our study is the first to highlight a compensatory role of cognitive resources in response to physical loss, among older-old adults with normal cognitive aging. Several of our results support this compensation view and give some insights on the intertwining with aging between physical and cognitive functioning to move forward the field of aging and everyday functioning. Additionally, underpinning Poli et al.'s recommendations [25] in their recent study, our findings stress the need for cognitive and psychosocial interventions for elders with physical loss, in order to counteract their vulnerability induced by their continuous cognitive efforts in everyday life. In doing so, we would further support the preservation of older adults' autonomy and promote successful aging.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Compliance with ethical standards

Funding This work was supported by the National French Institute of Informatics and Mathematics (Inria), the Public funds *Conseil Régional d'Aquitaine*, CNSA (*Caisse Nationale de la Solidarité pour l'Autonomie*), *Conseil Départemental de la Gironde*, and CARSAT Aquitaine (*Caisse d'Assurance Retraite et de la Santé au Travail)* and the *Fondation pour la Recherche Médicale*, (grant number : DOC20161136217; PI: Sauzéon).

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Statement of human and animal rights According to Helsinki declaration, approval was sought and obtained from the ethics committee of the Bordeaux University.

Informed consent All participants provided a written consent form prior to participation in the study.

Acknowledgments

The authors are very grateful to the services of UDCCAS Gironde that allowed them access to the elderly.

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